

REMARKS

The Examiner's Office Action of May 26, 2004 has been received and its contents reviewed. Applicants would like to thank the Examiner for the consideration given to the above-identified application.

By the above actions, claims 1 and 10 have been amended. Accordingly, claims 1-17 are pending for consideration, of which claims 1 and 10 are independent. In view of these actions and the following remarks, reconsideration of this application is now requested.

Referring now to the detailed Office Action, the drawings are objected to under 37 CFR 1.83(a) because they fail to show discharged gas supply pipe 35 as described in the specification. In response, Applicants are submitting herewith a replacement sheet for drawing Fig. 4 with discharged gas supply pipe 35 clearly labeled. Accordingly, the objection to the drawings is respectfully requested to be reconsidered and withdrawn.

Claims 1-5 stand rejected under 35 U.S.C. §10(b) as anticipated by PCT/NO099/00280 (hereafter PCT '280). Further, claims 6-11 stand rejected under 35 U.S.C. §103(a) as unpatentable over PCT '280 in view of Lahn et al. (U.S. Patent No. 5,160,456 – hereafter Lahn). Still further, claim 12 stands rejected under 35 U.S.C. §103(a) as unpatentable over prior art as applied in claim 11 and further in view Madgavkar et al. (U.S. Patent No. 4,186,801 – hereafter Madgavkar). Still further, claims 13-14 and 17 stand rejected under 35 U.S.C. 103(a) as being unpatentable over prior art as applied in claims 1-12 above, and further in view of Negishi (U.S. Patent No. 6,165,633). Finally, claims 15-16 stand rejected under 35 U.S.C. §103(a) as unpatentable over prior art as applied in claim 13, and further in view of Harashima (U.S. Patent No. 5,290,641). These rejections are respectfully traversed at least for the reasons provided below.

The amended claim 1 of the present invention recites a successive occurrence of a partial oxidation reaction and a water gas shift reaction. As amended, claims 1 and 10 recite, among other features, source fuel, oxygen, and steam being supplied to reformer (5) so that, within the fuel reformer (5), partial oxidation reaction occurs on catalyst (27).

According to Section 1 of the outstanding Office Action, PCT '280 discloses a partial oxidation reaction occurring on a catalyst of a fuel reformer (ATR), and a water gas shift reaction occurs due to the CO produced in the partial oxidation reaction. However, the shift reaction in PCT '280 does not occur in the fuel reformer (ATR), but rather in a shift reactor.

Hence PCT '280 merely discloses the occurrence of a partial oxidation reaction and a steam reforming reaction, but fails to disclose a shift reaction in page 5, line 29 to page 6, line 20. The occurrence of a shift reaction in a shift reactor is disclosed after page 6, line 21.

The data from Tables 1 and 2 of PCT '280 provide support that a shift reaction does not substantially occur in the ATR. With regard to Tables 1 and 2 of PCT '280, the CO_2/CO ratio and the $(\text{H}_2+\text{CO})/(\text{CO}+\text{CO}_2)$ ratio are calculated and included in the attached PCT '280 Table 1 and PCT '280 Table 2, and the ratios have been calculated for Table 1 on page 26 of the specification and included in that attached TABLE.

According to the TABLE, the CO_2/CO ratio in the present invention is 0.45-0.56. On the other hand, according to Table 1 and Table 2 of PCT '280, the CO_2/CO ratio is 0.10-0.34 at 1200°C and no shift reaction occurs. Although it seems like a shift reaction occurs since the CO_2/CO ratio increases as the temperature becomes 1000°C, 800°C or lower, no shift reaction has actually occurred, as can be seen in the $(\text{H}_2+\text{CO})/(\text{CO}+\text{CO}_2)$ ratio shown in the tables of PCT '280.

(H_2+CO) is the total quantity of H_2 and CO obtained from a reformer. In a case where a shift reaction ($\text{CO}+\text{H}_2\text{O}\rightarrow\text{H}_2+\text{CO}_2$) fully occurs, as CO becomes H_2 , the quantity of (H_2+CO) corresponds to that of H_2 . In addition, since C in CH_4 becomes either CO or CO_2 , the quantity of $(\text{CO}+\text{CO}_2)$ corresponds to that of CH_4 supplied to the reformer.

If all the CO produced in a partial oxidation reaction ($\text{CH}_4+1/2\text{O}_2\rightarrow\text{CO}+2\text{H}_2$) is used in a shift reaction ($\text{CO}+\text{H}_2\text{O}\rightarrow\text{H}_2+\text{CO}_2$), $\text{CH}_4+1/2\text{O}_2+\text{H}_2\text{O}$ becomes $3\text{H}_2+\text{CO}_2$, and since the amount of CO is zero, the $(\text{H}_2+\text{CO})/(\text{CO}+\text{CO}_2)$ ratio is equal to 3.

However, according to PCT '280, when $\text{S/C} = 0.5$, 800°C, the $(\text{H}_2+\text{CO})/(\text{CO}+\text{CO}_2)$ ratio is 1.76 (Table 1) and 1.5 (Table 2), and when $\text{S/C} = 1.8$, 800°C, the $(\text{H}_2+\text{CO})/(\text{CO}+\text{CO}_2)$ ratio is 2.14 (Table 1) and 1.97 (Table 2), thus the values are small. In view of the above, Applicants respectfully assert that, if the shift reaction occurs within the ATR and CO_2 is produced, the value of the ratio should be larger.

In other words, the reason for the CO_2/CO ratio increases, or the quantity of CO_2 increases, is not due to a shift reaction but rather due to other reactions, such as, for example, oxidation reactions of CO and CH_4 that produce CO_2 . Therefore, a shift reaction does not substantially occur in PCT '280.

On the other hand, according to the present invention, $(\text{H}_2+\text{CO})/(\text{CO}+\text{CO}_2)$ ratio is

2.50-2.72. Under the gas supply condition shown in the attached TABLE of the present invention, the $(\text{H}_2 + \text{CO})/(\text{CO} + \text{CO}_2)$ ratio is 2.88 when the partial oxidation reaction and the shift reaction occur ideally. Hence, in the present invention, the percentage of shift reaction in the fuel reformer is high, and the absorption percentage of H_2 is also high.

Further, since the speeds of partial oxidation reaction and shift reaction are faster than that of steam reforming reaction, the invention of the presently pending claims can achieve a more compact fuel reformer by performing the partial oxidation reaction and the shift reaction in one fuel reformer. This assertion is supported at least by, e.g., the data of $\text{SV} = 143000 \text{ h}^{-1}$ in TABLE 1 on page 26 of the present specification.

For the foregoing reasons, the invention of amended claim 1, as well as its dependent claims 2-5, is not anticipated by PCT '280.

With regard to claim 2, although PCT '280 discloses a CO_2/CO ratio of 0.2 or more, according to $\text{S/C} = 0.5$ at 1200°C in table 2 of PCT '280, the ratio of CO_2/CO is $4/30$, which is less than 0.2.

With regard to claim 5, according to the Section 1 of the Office Action, the Examiner alleges that PCT '280 discloses "the hydrogen gas generator with outlet gas temperature of said fuel reformer (ATR) is not more than 800 degrees centigrade (page 2, lines 7-8)". However, Applicants respectfully note that page 2, lines 7-8 of PCT '280 does not disclose the above. Contrary to Applicants' claimed invention, page 3, lines 7-8 of PCT '280 discloses a temperature of $800\text{-}1200^\circ\text{C}$.

In view of the arguments set forth above, the rejection of independent claim 1, as well as its dependent claims, under §102(b) over PCT '280, is respectfully requested to be reconsidered and withdrawn.

With regard to the §103(a) rejection of claims 6, 8 and 9, the Examiner asserts in Section 2 of the Office Action that the mole ratio of oxygen to fuel can be easily controlled, based on the teaching of Lahn, because the reaction zone of PCT '280 is maintained at a desired operating temperature. However, according to claims 6 and 8, the O_2/C ratio is set not to maintain the operating temperature but to prevent the occurrence of the steam reforming reaction while improving the efficiency of the partial oxidation reaction.

Moreover, according to Lahn, since the steam reforming reaction is an endothermic reaction, the operating temperature is maintained by combining the partial oxidation reaction,

which functions as an exothermic reaction, with the steam reforming reaction. On the other hand, it is an object of the presently claimed invention to prevent the occurrence of the steam reforming reaction. Therefore, the disclosed teaching of Lahn is very different from that of the presently claimed invention and cannot be combined with PCT '280.

With regard to claim 7, the Examiner asserts that based on Lahn, it is obvious that PCT '280 discloses increasing the O_2/C ratio to be larger than the O_2/C theoretical mixture ratio. However, it should be noted that the occurrence of the steam reforming reaction becomes difficult once the O_2/C ratio is increased. Hence, since PCT '280 intends to generate the steam reforming reaction, it is not obvious that PCT '280 discloses a large O_2/C ratio.

With respect to claim 10, which stands rejected for the same reasons as claims 1-9 in Section 2 of the Office Action, the presently claimed invention as amended has a feature of generating a partial oxidation reaction and a shift reaction and is different from PCT '280 and Lahn' 456. Accordingly, each condition for the reaction, such as the O_2/C ratio, the H_2O/C ratio, the CO_2/CO ratio and the temperature, is for generating the partial oxidation reaction and the shift reaction within a reformer. Further, each condition for the reaction is set to maintain a proper operating state. Based on the generating of the partial oxidation reaction and the shift reaction within a reformer, the reaction conditions for effectively generating the subsequent reactions are not obvious to one skilled in the art.

With regard to claim 11, although Lahn' 456 discloses using a catalyst selected from Group VII or Group VIII, it is for generating a steam reforming reaction. Hence Ni, which is suitable for steam reforming reaction, is particularly preferred (see column 4, lines 33-34). On the other hand, according to claim 11, based on the test result shown in the Attached TABLE of the present invention, in order to generate the partial oxidation reaction and the shift reaction, and to increase the yield of H_2 , Rh or Ru, instead of Ni, is preferred. Hence, because the reactions generated within the reformer of the present invention are different from those generated within the reformers of PCT '280 and Lahn, the use of Rh or Ru is not obvious to one skilled in the art, even with the teachings of Lahn.

For the foregoing reasons, claims 6-11 of the present invention are distinguishable over PCT '280 and Lahn.

With regard to the rejection of claim 12, Madgavkar discloses an oxidized catalyst

being supported on a honeycomb monolith carrier. However, according to claim 12, since Rh or Ru is supported on a honeycomb monolith carrier in order to generate the partial oxidation reaction and the shift reaction, and to increase the yield of H₂, claim 12 is distinguishable from Madgavkar.

With regard to claim 13, although Negishi discloses a fuel cell system, the feature of claim 13 resides in using one of the hydrogen gas generators of claims 1-12 in a fuel cell system. Hence claim 13 is distinguishable over Negishi.

In addition, since claims 14 and 17 are dependent claims of claim 13, claims 14 and 17 are also patentable over Negishi for the same reasons.

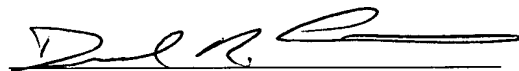
With regard to the rejection of claim 15, Harashima discloses controlling G1, G2, G3 and the flow rate of A to minimize the load regulation of the fuel cell. However, according to claim 15, the output current of the fuel cell is controlled so that the oxygen concentration and the steam concentration of the discharged gas that is supplied to the reformer are at a level suitable for the partial oxidation reaction and the shift reaction. Hence, claim 15 is distinguishable over Harashima.

In addition, since claim 16 is a dependent claim of claim 13, claim 16 is patentable for the same reasons.

The requirements for establishing a *prima facie* case of obviousness, as detailed in MPEP § 2143 - 2143.03 (pages 2100-122 - 2100-136), are: first, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference to combine the teachings; second, there must be a reasonable expectation of success; and, finally, the prior art reference (or references when combined) must teach or suggest all of the claim limitations. As the cited prior art references are deficient as set forth above, the §103(a) rejections are improper. Accordingly, Applicants respectfully request reconsideration and withdrawal of all the pending §103(a) rejections.

While the present application is now believed to be in condition for allowance, should the Examiner find some issue to remain unresolved, or should any new issues arise, which could be eliminated through discussions with Applicants' representative, then the Examiner is invited to contact the undersigned by telephone in order that the further prosecution of this application can thereby be expedited.

Respectfully submitted,



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ATTACHMENT

PCT' 280table 1

	S / C = 0 . 5			S / C = 1 . 8			S / C = 2 . 8		
Temp. °C	800	1000	1200	800	1000	1200	800	1000	1200
H ₂	40.9	59	65	52.9	65.6	66.8	58.8	67.9	69.2
CO	13.4	25.9	36.3	10.7	20.8	27.1	9.4	17.7	23.2
CO ₂	17.4	7.3	3.8	19	10.9	6.1	19.7	13.1	7.6
C ₁	28.2	7.8	1.0	17.5	2.7	0	12.1	1.3	0
CO ₂ /CO	13.0	0.28	0.10	1.78	0.52	0.23	2.10	0.74	0.33
(H ₂ +CO) / (CO+CO ₂)	1.76	2.56	2.53	2.14	2.73	2.83	2.34	2.78	3.00

PCT' 280table 2

	S / C = 0 . 5			S / C = 1 . 8			S / C = 2 . 8		
Temp. °C	800	1000	1200	800	1000	1200	800	1000	1200
H ₂	36.6	55.7	64	48.8	63.8	67	56	—	69.2
CO	11.7	—	30	9.4	19.9	24.6	7.8	19.4	23
CO ₂	19.4	6.4	4	20.1	11.6	8.0	—	9.6	7.8
C ₁	32.8	11.2	1.9	21.6	4.7	0.4	18.4	0	0
CO ₂ /CO	1.66	0.24	0.13	2.14	0.58	0.33	2.28	0.49	0.34
(H ₂ +CO) / (CO+CO ₂)	1.55	2.49	2.76	1.97	2.66	2.81	2.49	0.67	2.99



ATTACHMENT

TABLE

		Catalyst		
		N i	R h	R u
Feed gas	CH ₄	22.00	21.99	21.99
	O ₂	12.33	12.33	12.33
	H ₂ O	19.31	19.30	19.30
	N ₂	46.37	46.38	46.38
	S / C	0.88	0.88	0.88
Exit gas	H ₂	30.71	37.04	36.49
	CO	10.63	12.61	12.11
	CO ₂	5.90	5.66	5.96
	CH ₄	5.49	1.68	2.15
	N ₂	47.28	43.01	43.30
	CO ₂ /CO	0.56	0.45	0.49
	① (H ₂ +CO) / (CO+CO ₂)	2.50	2.72	2.69
	② theoretical ratio	2.88	2.88	2.88
	① / ②	0.869	0.944	0.935